AD-A128 712 THE REMOTE DATA RECORDER: AN ONBOARD RECORDER FOR THE (TRADEMARK) MAGNOGR..(U) NAVAL CIVIL ENGINEERING LAB PORT HUENEME CA L UNDERBAKKE FEB 83 NCEL-TN-1657 1/1

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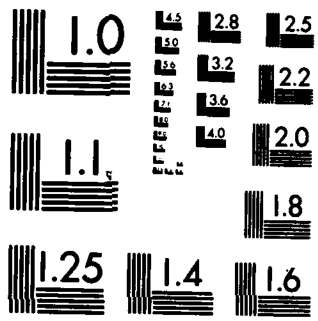

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TN NO: N-1657

TITLE: THE REMOTE DATA RECORDER: An Onboard Recorder for the Magnograph™ Nondestructive Test Wire Rope Sensor Head

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AUTHOR: L. Underbakke

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DATE: February 1983

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TECHNICAL NOTE

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PORT HUENEME, CALIFORNIA 93043

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METRIC CONVERSION FACTORS

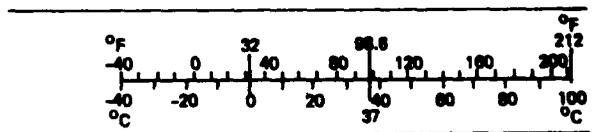
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Wire rope, steel cable, inspection, nondestructive test, nondestructive evaluation, electromagnetism, Hall effect sensors

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The remote data recorder allows the sensor head of the nondestructive test wire rope inspection device, the Magnograph^{TM}, to be used without being hardwired to the electronic recorder module. This allows the inspection of wire ropes in remote, hazardous, or inaccessible locations. This report describes the portable data recorder and presents the results of tests performed to evaluate its effectiveness in inspecting wire ropes that are inaccessible to close visual inspection.

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1. Nondestructive evaluation 2. Steel cable inspection I. YO995-01-004-620

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CONTENTS

INTRODUCTION

Objective

The objective of this report is to (1) describe a portable data recorder that can be mounted on the Magnograph™ wire rope inspection device and (2) present the results of tests performed to evaluate its effectiveness in inspecting wire ropes that are inaccessible to close visual inspection.

Background

The U.S. Navy has thousands of feet of wire rope being used on a wide variety of weight-handling equipment, and every foot of wire rope is required by Navy regulations to be inspected. This presents a problem to inspectors because only the outside of the wire rope is visible for inspection, and often the entire length is not easily accessible.

The traditional inspection procedure calls for the inspector to visually inspect the wire rope for broken wires, corrosion, and wear. The inspector may use a hand-held rag around the wire rope to snag (and thereby locate) broken wires (Figure 1). The diameter of the wire rope is also measured periodically with a caliper to quantify any wear. This procedure often places the inspector in a hazardous situation - holding onto a moving wire rope in a small, crowded machinery space or out on a crane boom. A safer technique is needed.

Electromagnetic nondestructive test (NDT) wire rope inspection equipment is now available that can provide the technical data needed to determine the condition of a wire rope. This equipment provides an inspector with the total number of internal as well as external broken wires and the total loss of metallic area due to wear and corrosion. This information enables the inspector to determine whether the wire rope meets minimum safety requirements.

NDT wire rope inspection devices have been tested and evaluated by the Naval Civil Engineering Laboratory (NCEL) under the sponsorship of the Naval Facilities Engineering Command (NAVFAC) and the Bureau of Mines. Of those tested, the Magnograph™ was found to be the most accurate while being the easiest to use (Ref 1). The Magnograph™ uses Hall Effect sensors and a strong, static magnetic field to detect broken wires, wear, and corrosion. The equipment normally consists of three parts: the electronic module, the recorder module, and the sensor head, plus an accessory box. The Magnograph™ was originally designed for the inspection of mining wire ropes from 1/2 to 2-1/2 inches in diameter.

As a result of field testing of NDT devices on large cranes (Figure 2), it was found that a remote data gathering device would make inspection simpler and safer. The Magnograph™ is usually supplied by the manufacturer with a 30-foot instrumentation cable between the sensor head and the electronic section. By removing this connection and replacing the cable with an onboard recorder, which is compatible with the cassette recorder/playback device in the electronic module of the Magnograph™, the sensor head can be used instead of the supplied instrumentation for cables in hazardous or inaccessible locations. The remote data recorder should be small and light enough to be carried piggy-back on the sensor head and allow data playback on the electronic and recorder section. The development and evaluation of the remote data recorder was performed under sponsorship of the Naval Facilities Engineering Command.

DESCRIPTION OF THE RECORDER UNIT

A remote data recorder (RDR) (Figure 3) was developed under contract to NCEL to meet these requirements by NORANDA Research. The remote data recorder consists of a unitized local fault (LF) and loss of metallic area (LMA) signal processor, distance transmitter logic, two-channel FM tape recorder, remote timer startup circuitry, and a power supply. These components are housed in a 20-pound package, which is below the specified maximum of 25 pounds. The RDR's measurements (7 inches wide, 16 inches long, and 5-1/2 inches high) allow it to be clipped to the framework of the sensor head (Figure 4).

The remote time startup circuitry allows the operator to start the tape recorder either by manual or auto start mode. Auto start sets the recorder to start from 1 minute to 12 hours 59 minutes after the RDR has been turned on and calibrated. This feature allows the sensor head/RDR to be moved to a remote or inaccessible area and secured before the recorder is started.

The RDR features a new concept in calibration, a five-position rotary master switch for the LMA zero-gain control. The positions are off, insert zero, -10%, standby, standardize, and run. Turning the master switch through these positions calibrates the electronics in about 30 seconds. The resulting cassette can be removed at the end of the test, rewound, and played back on the electronic and brush recorder sections of the Magnograph™, producing a brush chart recording in the same format and quality as a test using the sensor head, instrument cable, electronic section, and recorder section (Figure 5).

EVALUATION TESTS

Acceptance Tests

Acceptance tests were conducted to determine if the RDR met the design specifications: compatibility with the sensor head, display of data in the same format as the normal configuration of the Magnograph™, and operational endurance. In setting up the equipment for the tests, it was found that the clips provided to attach the RDR to the frame of the sensor head were inadequate to support the RDR under shock loading. These were replaced with stronger brackets.

A series of tests was conducted on NCEL's wire rope test track to ascertain if the data produced by the RDR were in the same format and responded to broken wires and corrosion in the calibrated wire ropes (Ref 2) as the original Magnograph™. The Magnograph™ was run in its original configuration first, on the calibrated wire rope as a control. The RDR was then run on the same calibrated wire rope with the same wire

rope speed. The two brush chart recordings were then compared for detection of broken wires and the loss of metallic area. The findings showed that the two brush chart recorders are virtually identical (Figure 6).

Operational endurance was evaluated by allowing the battery to run down to the "recharge battery" indicator and then recharging as per instructions provided with the equipment. The RDR, with a fully charged battery, will provide about 4 hours of continuous operation in the record mode. This is more than enough reserve electrical power for a 90-minute cassette tape (45 minutes each side) and will allow inspection of 72,000 feet of wire rope at 800 ft/min.

Field Test

As part of a trial test for the RDR, and to investigate the practicality of testing antenna guy wires, a test was arranged with the Naval Communication Unit, Cutler, Maine.

The guy wires at Cutler, Maine, are located near the ocean and are subject to salt-laden air. Also, during construction, several guy wires were pulled across a saltwater marsh area. These guys appeared to be rusted externally, causing concern about the strength of the guy wires.

The bridge strand guys on North Array tower N8, guy direction 2, (Figure 7), second and third levels were chosen because they were thought to be in the worst condition. Red rust on the exterior, along with patches of a silty sand, were visible along the full length of the third-level guys. The towers are about 800 feet tall, with four guy levels at approximately the 160-, 340-, 525-, and 755-foot levels. Each guy level has two guys per leg, about 8 feet apart. This results in 24 guys per tower.

The sensor head with the piggy-back recorder was pulled up the guy wires using a winch and wire rope device, which was designed to haul maintenance equipment up the guy, and pulled back down with a tag line (Figure 8). The first setup was on the right-hand side (upper) guy on level 2; this was the most accessible guy on which to test the hoist rigging and to solve any problems in raising or lowering the device. Guy level 2 right (lower) was tested next as the rigging worked well. Guy level 3 left and right were also tested using the same type of rigging.

The loss of metallic area (LMA) of both level 2 guys showed the most loss of steel, and in unexpected amounts. LMA readings were large (2-1/2%) at 10 yards from the anchor out to about 60 yards. From 60 to 75 yards the LMA was about 0%. The LMA changed gradually out to 100 yards with a maximum -6% loss, then increased to 1% LMA at the tower. These values assume the guy is in good condition at the 60- to 70-yard area. This loss does not seem to be directly related to internal corrosion, as the LF or LMA trace did not show any significant pitting or other corrosion-type signals. Level 3 right and left guys showed less than 1% LMA with minor pitting.

CONCLUSIONS

The remote data recorder duplicates the performance of the Magnograph™ as used with the instrumentation cable, allowing the inspection of wire rope where inspectors cannot or should not be allowed during the testing of running wire rope.

The RDR can be used in the following wire rope inspection applications:

1. Multiblock reeving on cranes where small spaces deny inspectors access

2. Wire ropes in hazardous areas, such as unventilated below-deck spaces, radioactive areas, or areas where the risk of explosion is great

3. Antenna guy wires

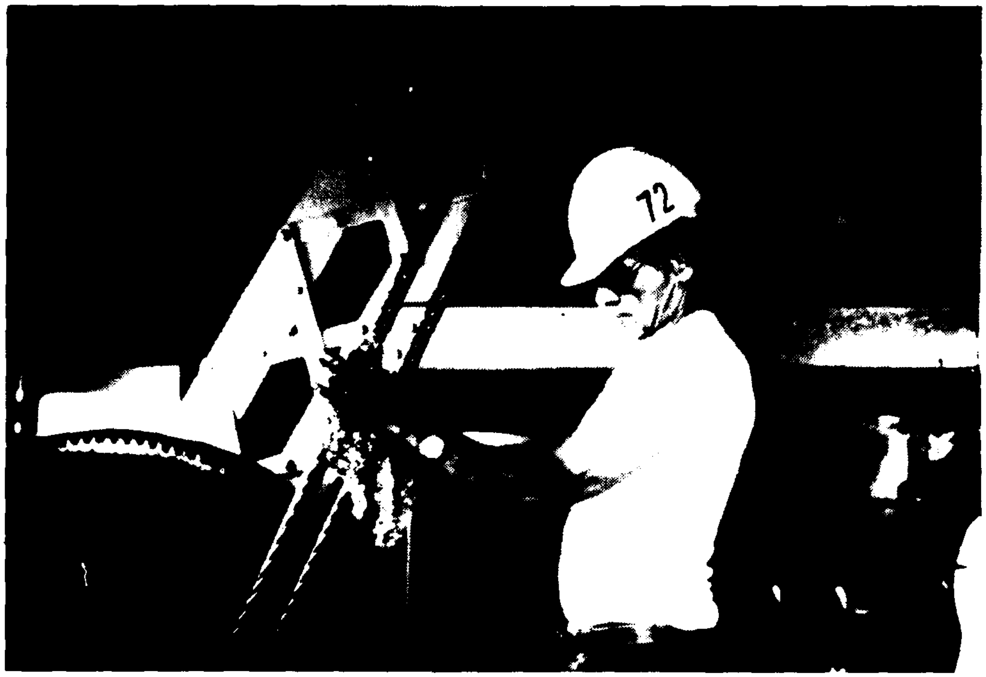


Figure 1. Inspector using rag-visual method to inspect crane load line.

Figure 2. Large crane in which nondestructive testing (NDT) wire rope inspection indicated remote NDT inspection would be helpful.

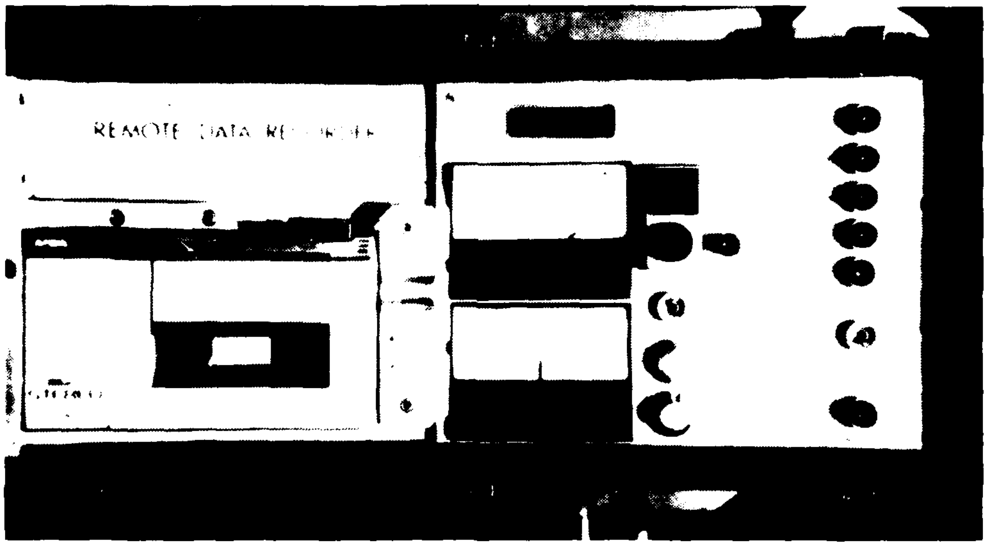


Figure 3. Face of RDR showing cassette recorder, calibrating dials, and remote startup controls.

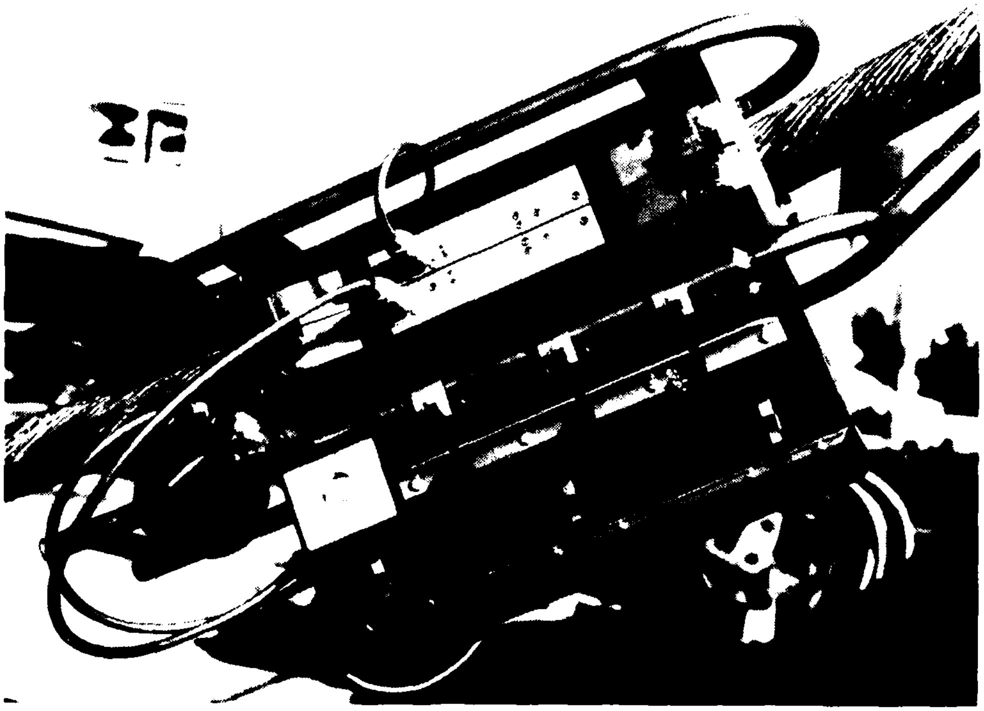
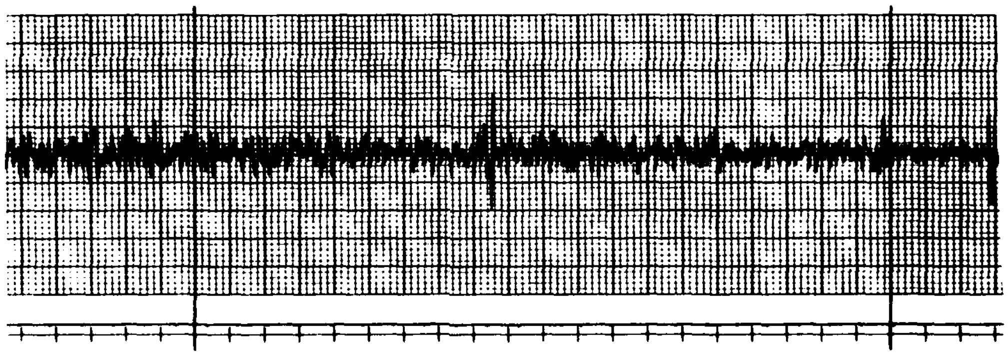


Figure 4. RDR piggyback on Magnograph^{TM} sensor head, as ready to be pulled up a guy wire.

Figure 5. Magnograph^{TM} being used in its original configuration. From left to right: electronic and recorder sections, instrument cable, and sensor head.



Remote Data Recorder

Magnograph

Figure 6. Remote data recorder recording and Magnograph^{TM} real-time recording.

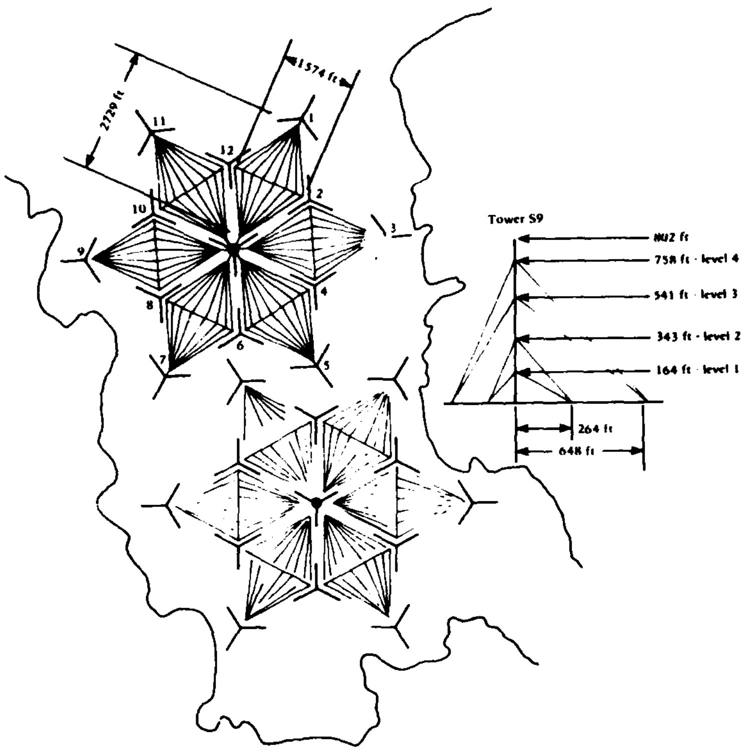


Figure 7. Location of project tower (N8).

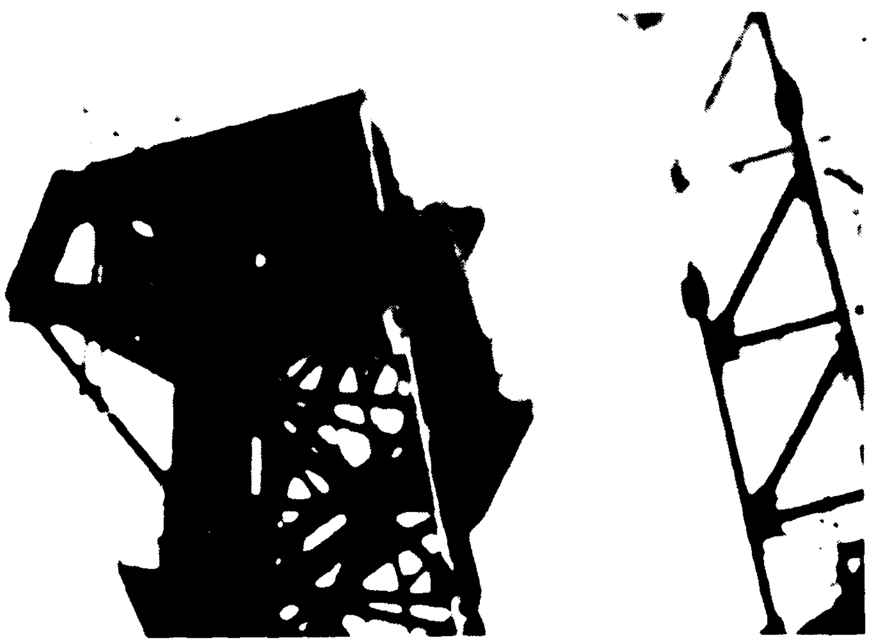


Figure 8. Sensor head/RDR being pulled up guy wire on tower.

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NAVFACENGCOM - SOUTH DIV. Code 90, RDT&ELO, Charleston SC; Library, Charleston, SC

NAVFACENGCOM - WEST DIV. 102; Code 04B San Bruno, CA; Library, San Bruno, CA; O9P/20 San Bruno, CA; RDT&ELO Code 2011 San Bruno, CA

NAVFACENGCOM CONTRACTS AROICC, NAVSTA Brooklyn, NY; ROICC, Point Mugu, CA; Colts Neck, NJ; Dir, Eng. Div., Exmouth, Australia; Eng Div dir, Southwest Pac, Manila, PI; OICC, Southwest Pac, Manila, PI; OICC-ROICC, NAS Oceana, Virginia Beach, VA; OICC/ROICC, Balboa Panama Canal; OICC/ROICC, Norfolk, VA; ROICC AF Guam; ROICC Code 495 Portsmouth VA; ROICC Key West FL; ROICC, Diego Garcia Island; ROICC, Keflavik, Iceland; ROICC, NAS, Corpus Christi, TX; ROICC, Pacific, San Bruno CA; ROICC, Yap; ROICC-OICC-SPA, Norfolk, VA

NAVMAG PWD - Engr Div, Guam; SCE, Subic Bay, R.P.

NAVOCEANO Code 3432 (J. DePalma), Bay St. Louis MS; Library Bay St. Louis, MS

NAVOCEANSYSCEN Code 4473 Bayside Library, San Diego, CA; Code 4473B (Tech Lib) San Diego, CA; Code 09 (Talkington), San Diego, CA; Code 5204 (J. Stachiw), San Diego, CA; Code 5214 (H. Wheeler), San Diego CA; Code 5221 (R.Jones) San Diego Ca; Code 5322 (Bachman) San Diego, CA; Code 6700, San Diego, CA; Hawaii Lab (R Yumori) Kailua, HI; Hi Lab Tech Lib Kailua HI

NAVPETOFF Code 30, Alexandria VA

NAVPGSCOL C. Morers Monterey CA; E. Thornton, Monterey CA

NAVPHIBASE CO, ACB 2 Norfolk, VA; COMNAVBEACHGRU TWO Norfolk VA; Code S3T, Norfolk VA; Dir. Amphib. Warfare Brd Staff, Norfolk, VA; Harbor Clearance Unit Two, Little Creek, VA; SCE Coronado, SD,CA

NAVRADRECFAC PWO, Kami Seya Japan

NAVREGMEDCEN PWD - Engr Div, Camp Lejeune, NC; PWO, Camp Lejeune, NC; SCE; SCE, Camp Pendleton CA; SCE, Guam; SCE, Newport, RI

NAVSCOLCECOFF C35 Port Hueneme, CA; CO, Code C44A Port Hueneme, CA

NAVSCSOL PWO, Athens GA

NAVSEASYSCOM Code OOC-D, Washington, DC; Code PMS 395 A 3, Washington, DC; Code PMS 395 A2, Washington, DC; Code SEA OOC Washington, DC; PMS-395 A1, Washington, DC; PMS395-A3, Washington, DC; SEA 04E (L Kess) Washington, DC; SEA05E1, Washington, D.C.

NAVSECGRUACT Facil. Off., Galeta Is. Panama Canal; PWO, Adak AK; PWO, Edzell Scotland; PWO, Puerto Rico; PWO, Torri Sta, Okinawa; Security Offr, Winter Harbor ME

NAVSHIPREPFAC Library, Guam; SCE Subic Bay

NAVSHIPYD Bremerton, WA (Carr Inlet Acoustic Range); Code 134, Pearl Harbor, HI; Code 202.4, Long Beach CA; Code 202.5 (Library) Puget Sound, Bremerton WA; Code 380, Portsmouth, VA; Code 400, Puget Sound; Code 410, Mare Is., Vallejo CA; Code 440 Portsmouth NH; Code 440, Norfolk; Code 440, Puget Sound, Bremerton WA; L.D. Vivian; Library, Portsmouth NH; PWD (Code 420) Dir Portsmouth, VA; PWD (Code 450-HD) Portsmouth, VA; PWD (Code 457-HD) Shop 07, Portsmouth, VA; PWD (Code 460) Portsmouth, VA; PWO, Bremerton, WA; PWO, Mare Is.; PWO, Puget Sound; SCE, Pearl Harbor HI; Tech Library, Vallejo, CA

NAVSTA CO Roosevelt Roads P.R. Puerto Rico; Dir Engr Div, PWD, Mayport FL; Engr. Dir., Rota Spain; Long Beach, CA; Maint. Cont. Div., Guantanamo Bay Cuba; Maint. Div. Dir/Code 531, Rodman Panama Canal; PWD (LTJG.P.M. Motolenich), Puerto Rico; PWD - Engr Dept, Adak, AK; PWD - Engr Div, Midway Is.; PWO, Guantanamo Bay Cuba; PWO, Keflavik Iceland; PWO, Mayport FL; SCE, Guam; SCE, Pearl Harbor HI; SCE, San Diego CA; SCE, Subic Bay, R.P.; Security Offr, San Francisco, CA; Utilities Engr Off. Rota Spain

NAVSUBASE SCE, Pearl Harbor HI

NAVSURFWPNCEN PWO, White Oak, Silver Spring, MD

NAVTECHTRACEN SCE, Pensacola FL

NAVWPNCEN Code 2636 China Lake; Code 266, China Lake, CA; Code 3803 China Lake, CA; ROICC (Code 702), China Lake CA

NAVWPNEVALFAC Sec Offr, Kirtland AFB, NM

NAVWPNSTA (Clebak) Colts Neck, NJ; Code 092, Colts Neck NJ; Code 092, Concord CA; Maint. Control Dir., Yorktown VA

NAVWPNSTA PW Office Yorktown, VA

NAVWPNSTA PWD - Maint. Control Div., Concord, CA; PWD - Supr Gen Engr, Seal Beach, CA; PWO, Charleston, SC; PWO, Seal Beach CA

NAVWPNSUPPCEN Code 09 Crane IN

NCTC Const. Elec. School, Port Hueneme, CA

NCBC Code 10 Davisville, RI; Code 15, Port Hueneme CA; Code 155, Port Hueneme CA; Code 156, Port Hueneme, CA; Code 1571, Port Hueneme, CA; PWO (Code 80) Port Hueneme, CA; PWO, Davisville RI

NCBU 411 OIC, Norfolk VA

NCR 20, Code R70; 20, Commander; 30th Det, OIC, Diego Garcia I

NMCB 74, CO; FIVE, Operations Dept; Forty, CO; THREE, Operations Off.

NOAA (Dr. T. Mc Guinness) Rockville, MD; Library Rockville, MD

NORDA Code 410 Bay St. Louis, MS; Code 440 (Ocean Rsch Off) Bay St. Louis MS; Code 500, (Ocean Prog Off-Ferer) Bay St. Louis, MS
NRL Code 5800 Washington, DC; Code 5843 (F. Rosenthal) Washington, DC; Code 8441 (R.A. Skop), Washington DC
NROTC J.W. Stephenson, UC, Berkeley, CA
NSC Code 54.1 Norfolk, VA
NSD SCE, Subic Bay, R.P.
NTC OICC, CBU-401, Great Lakes IL
NUCLEAR REGULATORY COMMISSION T.C. Johnson, Washington, DC
NUSC Code 131 New London, CT; Code 332, B-80 (J. Wilcox) New London, CT; Code EA123 (R.S. Munn), New London CT; Code TA131 (G. De la Cruz), New London CT
OFFICE SECRETARY OF DEFENSE ASD (MRA&L) Code CSS/CC Washington, DC
ONR Central Regional Office, Boston, MA; Code 481, Bay St. Louis, MS; Code 485 (Silva) Arlington, VA; Code 700F Arlington VA
PACMISRANFAC HI Area Bkg Sands, PWO Kekaha, Kauai, HI
PHIBCB 1 P&E, San Diego, CA; 1, CO San Diego, CA; 1, CSWC D Wellington, San Diego, CA
PMTC Code 3144, (E. Good) Point Mugu, CA; Code 3331 (S. Opatowsky) Point Mugu, CA; Code 4253-3, Point Mugu, CA; EOD Mobile Unit, Point Mugu, CA; Pat. Counsel, Point Mugu CA
PWC CO Norfolk, VA; CO, (Code 10), Oakland, CA; CO, Great Lakes IL; CO, Pearl Harbor HI; Code 10, Great Lakes, IL; Code 105 Oakland, CA; Code 110, Oakland, CA; Code 120, Oakland CA; Library, Code 120C, San Diego, CA; Code 128, Guam; Code 154 (Library), Great Lakes, IL; Code 200, Great Lakes IL; Code 200, Guam; Code 400, Great Lakes, IL; Commanding Officer, Subic Bay; Code 400, Pearl Harbor, HI; Code 400, San Diego, CA; Code 420, Great Lakes, IL; Code 420, Oakland, CA; Code 424, Norfolk, VA; Code 500 Norfolk, VA; Code 505A Oakland, CA; Code 600, Great Lakes, IL; Code 700, Great Lakes, IL; Code 700, Norfolk, VA; Code 700, San Diego, CA; Library, Guam; Library, Norfolk, VA; Library, Oakland, CA; Library, Pearl Harbor, HI; Library, Pensacola, FL; Library, Subic Bay, R.P.; Library, Yokosuka JA; Utilities Officer, Guam ; Library, Yokosuka, JA; Library, Pensacola, FL
SUPANX PWO, Williamsburg VA
TVA Solar Group, Arnold, Knoxville, TN
UCT ONE OIC, Norfolk, VA
UCT TWO OIC, Port Hueneme CA
US DEPT OF INTERIOR Bur of Land Mgmnt Code 583, Washington DC
US GEOLOGICAL SURVEY Off. Marine Geology, Piteleki, Reston VA
US NAVAL FORCES Korea (ENJ-P&O)
USCG (G-MP-3/USP/82) Washington Dc; (Smith), Washington, DC; G-EOE-4 (T Dowd), Washington, DC
USCG R&D CENTER CO Groton, CT; D. Motherway, Groton CT
USDA Forest Products Lab. (R. DeGroot), Madison WI; Forest Service Reg 3 (R. Brown) Albuquerque, NM; Forest Service, Bowers, Atlanta, GA; Forest Service, San Dimas, CA
USNA ENGRNG Div. PWD, Annapolis MD; PWO Annapolis MD; USNA/Sys Eng Dept, Annapolis, MD
USS FULTON WPNS Rep. Offr (W-3) New York, NY
WATER & POWER RESOURCES SERVICE (Smoak) Denver, CO
GEORGIA INSTITUTE OF TECHNOLOGY (LT R. Johnson) Atlanta, GA
NUSC Library, Newport, RI

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